The invention in which an exclusive right is claimed is defined by the following:

1. A valve configured for generating a pressure pulse within a conduit by at least partially interrupting flow of a pressurized fluid circulating through the conduit, comprising:

(a) an inlet port configured to couple in fluid communication with the conduit through which the pressurized fluid is circulating;

(b) an outlet port configured to couple in fluid communication with the conduit through which the pressurized fluid is circulating;

(c) a plurality of fluid passages configured to selectively couple in fluid communication with said inlet port;

(d) a poppet that is actuated by the pressurized fluid to cycle between an open position and a closed position, such that when in said closed position, said poppet at least partially interrupts a flow of the pressurized fluid through said outlet port; and

(e) a pilot disposed within said poppet, said pilot being reciprocated back and forth between first and second positions during each cycle by the pressurized fluid, such that a position of said pilot determines which of said plurality of fluid passages is coupled in fluid communication with said inlet port.

2. The valve of Claim 1, wherein the plurality of fluid passages include at least one fluid passage configured to divert a flow of pressurized fluid upstream of said outlet port when said poppet is in the closed position, thereby substantially reducing a water hammer effect.

3. The valve of Claim 1, wherein the plurality of fluid passages include at least one fluid passage configured to divert a flow of pressurized fluid downstream of said outlet port when said poppet is in the closed position, thereby at least partially reducing a water hammer effect.

4. The valve of Claim 1, wherein said pilot is coaxially disposed within said poppet.

5. The valve of Claim 1, wherein said plurality of fluid passages include:

(a) a first passage through which the pressurized fluid is applied to said poppet to cause said poppet to cycle to said closed position, thereby closing said outlet port, when said pilot is in said first position,

(b) a second passage through which the pressurized fluid is applied to said pilot to cause said pilot to shift to said second position when said poppet is in said closed position;

(c) a third passage through which the pressurized fluid is applied to said poppet to cause said poppet to cycle to said open position when said pilot is in said second position; and

(d) a fourth passage through which the pressurized fluid is applied to said pilot to cause said pilot to shift to said first position when said poppet is in said open position.

6. The valve of Claim 1, wherein a cycle time of the valve is a function of a size of said plurality of fluid passages.

7. The valve of Claim 1, wherein said pilot is configured to move with said poppet when said pilot is in said first position, such that when said poppet moves from said open position to said closed position, a momentum imparted to said pilot facilitates said pilot shifting to said second position.

8. The valve of Claim 1, wherein said poppet comprises a first bushing and a second bushing, said first and second bushings being configured to limit a range of motion of said pilot within said poppet.

9. The valve of Claim 1, further comprising a housing in which the valve is disposed.

10. The valve of Claim 9, wherein said housing is adapted to be incorporated in a drillstring.

11. The valve of Claim 9, wherein said housing is configured to isolate a section of conduit, such that the at least partial interruption of pressurized fluid in the conduit by the valve generates a negative pressure pulse in said section of conduit that is isolated.

12. The valve of Claim 11, wherein said housing comprises a high speed flow course adapted to couple said section of conduit that is isolated in fluid communication with a non-isolated section of conduit.

13. The valve of Claim 12, wherein a cycle time required for the poppet to cycle between the open position and the closed position is less than or equal to a two-way travel time of an acoustic pressure wave in a length of the high speed flow course.

14. The valve of Claim 1, further comprising an on/off mechanism having an on position and an off position, such that when said on/off mechanism is in said off position, said poppet is held in said open position, preventing the valve from cycling.

15. The valve of Claim 14, wherein said on/off mechanism is sensitive to a pressure in the conduit, such that said on/off mechanism changes from said off position to said on position after the pressure within the conduit reaches a predetermined level.

16. The valve of Claim 1, wherein the at least partial interruption of the flow of pressurized fluid by actuation of the valve generates a pressure pulse that propagates away from the valve.

17. The valve of Claim 1, further comprising a frequency modulator configured to repeatedly vary the cycle rate of the valve.

18. The valve of Claim 17, wherein said frequency modulator comprises a variable volume in fluid communication with a timing shaft, said timing shaft being coupled with said pilot, such that a change in said variable volume produces a corresponding change in a motion of said pilot, thereby changing a cycling rate of the valve.

19. The valve of Claim 18, wherein said frequency modulator changes said variable volume after the valve completes each cycle.

20. The valve of Claim 18, wherein said frequency modulator comprises a rotary indexing mechanism that changes said variable volume after the valve completes each cycle, such that each complete revolution of said rotary indexing mechanism generates a substantially similar modification of the valve cycle.

21. Apparatus for at least partially interrupting flow of a pressurized fluid that is circulating though a conduit, comprising:

(a) a housing; and

(b) a valve substantially enclosed by said housing, said valve comprising;

(i) an inlet port configured to couple in fluid communication with the conduit through which the pressurized fluid is circulating;

(ii) an outlet port configured to couple in fluid communication with the conduit through which the pressurized fluid is circulating;

(iii) a plurality of fluid passages configured to selectively couple in fluid communication with said inlet port;

(iv) a first member that is actuated by the pressurized fluid to cycle between an open position and a closed position, such that when in said closed position, said first member at least partially interrupts a flow of the pressurized fluid through the outlet port; and

(v) a second member disposed within said first member, the second member being reciprocated back and forth between first and second positions during each cycle by the pressurized fluid, a position of said second member determining which of said plurality of fluid passages is coupled in fluid communication with said inlet port.

22. The apparatus of Claim 21, wherein said plurality of passages comprises:

(a) a first passage through which the pressurized fluid is applied to said first member to cause said first member to cycle to said closed position, thereby closing the outlet port, when said second member is in said first position,

(b) a second passage through which the pressurized fluid is applied to said second member to cause said second member to shift to said second position when said first member is in said closed position;

(c) a third passage through which the pressurized fluid is applied to said first member to cause said first member to cycle to said open position when said second member is in said second position; and

(d) a fourth passage through which the pressurized fluid is applied to said second member to cause said second member to shift to said first position when said first member is in said open position.

23. The apparatus of Claim 22, wherein said second member is configured to move with said first member, such that when said second member is in said first position and said first member moves from said open position to said closed position, the movement of said first member imparts a momentum to said second member, thereby urging said second member to move to said second position.

24. The apparatus of Claim 21, wherein said second member is disposed coaxially within said first member.

25. The apparatus of Claim 21, wherein said housing is configured to isolate a portion of the conduit, such that when the portion of the conduit that is isolated is coupled in fluid communication with a portion of the conduit that is not isolated by a high velocity fluid flow course, interruption of pressurized fluid in the conduit by cycling the valve causes a negative pressure pulse in the section that is isolated.

26. The apparatus of Claim 25, wherein the high velocity flow course is defined at least in part by the housing.

27. The apparatus of Claim 21, wherein when the conduit is disposed inside a borehole, the at least partial interruption of the flow of pressurized fluid caused by the valve generating a seismic pulse that propagates into a formation surrounding the borehole adjacent to the valve, the seismic pulse enabling information about the formation and about a location of the valve to be determined.

28. The apparatus of Claim 21, wherein when the apparatus is disposed at a closed end of the conduit, the at least partial interruption of the flow of pressurized fluid by the valve generates a pressure pulse that propagates upstream of the valve while the valve is closed, thereby transferring a momentum of the fluid to the apparatus to urge the apparatus to move in a downstream direction.

29. The apparatus of Claim 21, wherein said plurality of passages comprises at least one fluid passage configured to divert a flow of pressurized fluid away from said outlet port when said first member is in the closed position, thereby at least partially reducing a water hammer effect.

30. A method for generating pressure pulses within a conduit, comprising the steps of:

(a) coupling a pressure activated flow interruption valve to the conduit, the valve being configured to periodically interrupt a flow of the pressurized fluid in the conduit, a flow of the pressurized fluid through the valve causing the valve to cycle between an open position and a closed position;

(b) circulating a pressurized fluid through the conduit; and

(c) directing the pressurized fluid through the valve to cyclically actuate the valve, thereby periodically interrupting a flow of the pressurized fluid in the conduit as the valve cycles between the open position and the closed position.

31. A method for imparting vibrations to a drillstring to reduce friction in vertical, horizontal, inclined, or extended reach wells by cyclically interrupting fluid flow through the drillstring, comprising the steps of :

(a) inserting a drillstring into a well;

(b) circulating a pressurized fluid through the well; and

(c) periodically interrupting a flow of the pressurized fluid at a selected point within the well to produce pressure pulses, the pressure pulses imparting vibrations to the drillstring, thereby reducing friction between the drillstring and the well.

32. The method of Claim 32, further comprising the step of redirecting at least a portion of said flow of the pressurized fluid within the well such that the step of periodically interrupting a flow of the pressurized fluid does not completely interrupt a flow of the pressurized fluid in the portion of the well into which the flow of pressurized fluid is redirected.

33. A method for reducing differential sticking of a drillstring to a borehole wall by cyclically interrupting fluid flow through the drillstring, comprising the steps of:

(a) circulating a pressurized fluid through the drillstring in the well; and

(b) periodically interrupting a flow of the pressurized fluid at a selected point within the drillstring to produce pressure pulses, the pressure pulses imparting vibrations to the drillstring, thereby reducing differential sticking of the drillstring to a borehole wall of the well.

34. A method for reducing undesirable bit and drillstring motions including a whirl, a stick-slip, a wind-up, and bounce, comprising the steps of:

(a) inserting a drillstring into a well;

(b) circulating a pressurized fluid through the well; and

(c) periodically interrupting a flow of the pressurized fluid at a selected point within the well to produce pressure pulses, the pressure pulses imparting vibrations to the drillstring, thereby reducing whirl, stick-slip, wind-up and bounce of the drillstring.

35. Apparatus for at least partially interrupting a flow of a pressurized fluid that is circulating though a conduit, to generate pressure pulses, a frequency of the pressure pulses varying in a repetitive pattern, comprising:

(a) a valve substantially enclosed by a housing, said valve including:

(i) a first member that is actuated by the pressurized fluid to cycle between an open position and a closed position, such that when in said closed position, said first member at least partially interrupts a flow of the pressurized fluid through an outlet port, thereby generating a pressure pulse; and

(ii) a second member disposed within said first member, the second member being reciprocated back and forth between first and second positions during each cycle by the pressurized fluid, such that a position of said

second member controls a timing of the valve changing between an open state and a closed state; and

(b) a frequency modulator varies the timing of said valve by varying a stroke of said second member in a repetitive pattern, such that the frequency of the pressure pulses is varied in a manner corresponding to the repetitive pattern of the second member.

36. The apparatus of Claim 35, wherein the frequency modulator comprises a variable volume coupled to said second member, such that a change in said variable volume results in a change in a reciprocating motion of said second member.

37. The apparatus of Claim 36, wherein the frequency modulator further comprises a timing shaft that slidingly engages the second member during at least a portion of the reciprocating motion of said second member, said timing shaft being in fluid communication with said variable volume such that when said timing shaft engages said second member, said timing shaft acts as a piston to pump the pressurized fluid through said variable volume, a change in volume of the variable volume resulting in a change in a travel time of said timing shaft, the change in the travel time of said timing shaft causing a corresponding change in a travel time of said second member.

38. The apparatus of Claim 37, wherein the frequency modulator further comprises an indexing mechanism coupled with said timing shaft, said indexing mechanism changing said variable volume each time said second member engages said timing shaft.

39. The apparatus of Claim 38, wherein said indexing mechanism comprises an angled ratchet and pawl mechanism that converts an axial motion of said timing shaft to a rotary motion of said indexing mechanism, such that after a predefined revolution of said indexing mechanism, a pattern with which the frequency of the pressure pulses is varied repeats.

40. Apparatus for generating a series of impulsive pressure pulses having a repeat period between successive impulsive pressure pulses that is regularly varied, said impulsive pressure pulses propagating into a formation surrounding a borehole, comprising:

(a) a housing adapted to be coupled into a drillstring, adjacent to a drill bit;

(b) a valve substantially enclosed by said housing, said valve comprising a poppet whose position determines whether the valve is open or closed, and a pilot spool whose motion determines a timing of the valve, impulsive pressure pulses being generated each time said valve closes, the pilot spool and poppet cooperating to redirect a flow of drilling fluid to achieve a reciprocating motion within the housing to periodically open and close the valve; and

(c) a variable flow restrictor substantially disposed within said housing, said variable flow restrictor regularly varying the timing of said valve by limiting an axial velocity of the pilot spool, each variation in the timing of the valve varying the repeat period between successive impulsive pressure pulses.

41. The apparatus of Claim 40, wherein the variable flow restrictor comprises:

(a) a shaft that slidingly engages the pilot spool during at least a portion of the reciprocating motion of said pilot spool;

(b) a variable volume in fluid communication with the shaft, such that said shaft acts as a piston to pump drilling fluid through said variable volume, a change in a volume of the variable volume resulting in a change in a travel time of said shaft, the change in the travel time of said shaft resulting in a corresponding change in a travel time of said pilot spool; and

(c) a rotary indexing mechanism coupled with said shaft, said rotary indexing mechanism being configured to change said variable volume each time said pilot spool engages said shaft, such that a predefined number of

revolutions of said rotary indexing mechanism defines an iterative pattern that controls varying the repeat period between successive impulsive pressure pulses.

42. The apparatus of Claim 40, wherein said valve generates impulsive pressure pulses having substantially the same amplitude and duration.

43. The apparatus of Claim 40, wherein said variable flow restrictor comprises a rotary indexing mechanism configured to convert an axial motion of said pilot spool to a rotary motion of said rotary indexing mechanism.

44. The apparatus of Claim 40, wherein said variable flow restrictor is actuated by an external motor.

45. The apparatus of Claim 40, wherein said variable flow restrictor causes the repeat period between successive impulsive pressure pulses to vary in accord with an iterative pattern, such that within each iteration of said iterative pattern, the repeat period between successive impulsive pressure pulses is varied by at least a factor of two.

46. The apparatus of Claim 40, wherein said variable flow restrictor causes the repeat period between successive impulsive pressure pulses to vary in accord with an iterative pattern, such that within each iteration of said iterative pattern, the repeat period between successive impulsive pressure pulses is varied linearly.

47. The apparatus of Claim 40, wherein said valve closes in less than 10 milliseconds

48. The apparatus of Claim 40, further comprising a pressure-actuated on/off valve that disables said valve and said variable flow restrictor until at least a predefined pressure is applied to said on/off valve.

49. The apparatus of Claim 48, wherein the on/off valve comprises a spring and a pressure balancing piston selected to respond to the predefined pressure by changing the on/off valve to an on state, wherein said predefined pressure is a start pressure that is higher than a stop pressure at which the on/off valve changes to an off state.

50. The apparatus of Claim 40, wherein said housing comprises external flow courses that increase an upwards velocity of drilling fluid in the borehole outside of said housing, said flow courses limiting a duration and an axial distribution of the impulsive pressure pulse generated when said valve closes.

51. The apparatus of Claim 40, wherein said housing is assembled as a unitary cartridge with stab-joint seals so that the housing is adapted for insertion into a drillstring sub disposed above the drill bit, enabling an insertion and retrieval of said unitary cartridge by a wire line from the surface without removing the drillstring from a borehole.

52. A seismic while drilling system, comprising:

(a) a drillstring including a drill bit and a seismic source, said seismic source comprising:

(i) a valve having a poppet whose motion and position determines whether the valve is open or closed; and a pilot spool whose motion and position determines a timing of the valve periodically opening and closing, seismic pressure pulses being generated each time said valve closes, the pilot spool and poppet cooperating to redirect a flow of drilling fluid to achieve a reciprocating motion; and

(ii) a frequency modulator configured to regularly vary the timing of said valve by varying a stroke of said pilot spool in a repetitive pattern to achieve seismic pressure pulses having a frequency that is varied in a repetitive pattern; and

(b) at least one seismic receiver for observing seismic waves caused by the seismic pressure pulses generated by said valve.

53. The seismic while drilling system of Claim 52, further comprising a pilot signal receiver adapted to be disposed in a drilling rig used to introduce said drillstring into a borehole.

54. The seismic while drilling system of Claim 52, further comprising a correlator configured to cross-correlate a pilot signal with a seismic signal corresponding to the seismic waves caused by the seismic pressure pulses generated by said valve, to generate a seismic record.

55. The seismic while drilling system of Claim 54, wherein the correlator comprises a logic processor configured to:

(a) convert the pilot signal to an impulse timing function with a unit value when the pilot signal rises through a threshold, and a zero value at other times; and

(b) cross-correlate the impulse timing function with the seismic signal to generate the seismic record.

56. The seismic while drilling system of Claim 52, wherein the drill bit comprises at least one of a drag bit and a roller cone bit.

57. A method for performing seismic analysis while drilling, comprising the steps of:

(a) inserting a drillstring including a drill bit into a borehole;

(b) circulating a pressurized fluid through the borehole to activate the drill bit to start drilling;

(c) during the drilling by the drill bit, periodically interrupting a flow of the pressurized fluid to the drill bit at a selected point within the well to produce seismic pulses;

(d) periodically varying a timing between each successive interruption in a repetitive pattern;

(e) collecting seismic data for the seismic pulses while drilling; and

(f) analyzing the seismic data for the repetitive pattern used to generate the seismic pulses, to filter out seismic noise from other sources.

58. The method of Claim 57, wherein the repetitive pattern is characterized by varying the timing between each successive interruption by a factor of two.

59. The method of Claim 57, wherein each successive seismic pulse has substantially the same amplitude and duration.

60. The method of Claim 57, wherein the step of analyzing the seismic data is achieved using a hardware correlator.

61. The method of Claim 57, wherein the step of collecting the seismic data while drilling comprises the step of cross-correlating the seismic data at the surface with a pilot signal from a pilot acoustic receiver that is disposed on the drillstring.

62. The method of Claim 57, wherein the step of collecting seismic data while drilling comprises the step of affixing at least one seismic receiver on the drillstring.

63. The method of Claim 57, wherein an entrance to the borehole is at ground level, and wherein the step of collecting seismic data while drilling comprises the step of receiving a signal from at least one seismic receiver disposed at ground level.

64. The method of Claim 57, wherein the entrance to the borehole is on the seafloor, and wherein the step of collecting seismic data while drilling comprises the step of receiving a signal from at least one seismic receiver disposed on the seafloor.

65. The method of Claim 57, further comprising the step of positioning the drill bit off the bottom of the borehole to collect seismic data to be used to identify drillstring multiples and rig noise for processing a seismic travel time record.

66. The method of Claim 65, further comprising the step of comparing seismic data obtained while the bit was off the bottom with seismic data obtained while the bit was on the bottom of the borehole to improve shear wave arrival detection.

67. A method for generating seismic pulses to evaluate characteristics of a formation adjacent to a borehole, comprising the steps of:

(a) circulating a pressurized fluid through a conduit that extends into the borehole;

(b) periodically at least partially interrupting a flow of the pressurized fluid at a selected point within the borehole to generate seismic pulses, said seismic pulses radiating from the borehole into a formation adjacent to the borehole, a timing between successive interruptions of the flow being varied according to a repetitive pattern; and

(c) redirecting at least a portion of said flow of the pressurized fluid within the conduit such that the step of partially interrupting a flow of the pressurized fluid at a selected point within the borehole does not completely interrupt a circulation of the pressurized fluid from an inlet of said conduit to said selected point, thereby preventing generation of a water hammer effect.

68. A method for removing scale from within a tube that extends through at least part of a borehole, comprising the steps of:

(a) circulating a pressurized fluid through a conduit that extends into the tube;

(b) periodically at least partially interrupting a flow of the pressurized fluid at a selected point within the borehole to generate negative

pressure pulses, a timing between each successive interruption being varied according to a repetitive pattern; and

(c) propagating the negative pressure pulses within the tube so that the scale is exposed thereto, said negative pressure pulses removing the scale from an internal surface of the tube.

69. A method for removing fines from a section of a wall of a borehole, comprising the steps of:

(a) circulating a pressurized fluid through a high velocity flow course disposed in the borehole;

(b) periodically reducing a flow of the pressurized fluid through the high velocity flow course to generate negative pressure pulses, a timing between each successive reduction being varied according to a repetitive pattern; and

(c) propagating the negative pressure pulses into a wall of the borehole, said negative pressure pulses drawing the fines from the wall.

70. A method for clearing debris and fines from a plurality of perforations extending through a wall of a borehole, comprising the steps of:

(a) circulating a pressurized fluid through a high velocity flow course disposed in the borehole;

(b) periodically reducing a flow of the pressurized fluid through the high velocity flow course to generate negative pressure pulses, a timing between each successive reduction being varied according to a repetitive pattern; and

(c) propagating the negative pressure pulses into the plurality of perforations extending through the wall of the borehole, said negative pressure pulses removing debris and fines from said plurality of perforations.

71. A method for weakening rock within a borehole, comprising the steps of:

(a) circulating a pressurized fluid through a high velocity flow course that is disposed within the borehole;

(b) periodically interrupting a flow of the pressurized fluid through the high velocity flow course to generate negative pressure pulses, a timing between each successive interruption being varied according to a repetitive pattern; and

(c) propagating the negative pressure pulses toward the rock, said negative pressure pulses applying impulsive differential pressures of sufficient magnitude to the rock to weaken the rock, thereby enabling the rock to be more readily penetrated with a drill bit.

72. A method for detecting changes in pore pressure gradients within a borehole, comprising the steps of:

(a) periodically producing both pressure and shear waves originating at the bottom of the borehole;

(b) collecting data corresponding to the pressure and shear waves to generate pressure and shear wave velocity profiles; and

(c) analyzing the shear wave velocity profiles to detect any change, a change in the shear wave profiles being indicative of a change in pore pressure gradients.

73. The method of Claim 72, wherein the step of periodically producing shear waves originating at the bottom of the borehole comprises the steps of:

(a) positioning a pulse generating tool including a high velocity flow course at the bottom of the borehole; and

(b) circulating a pressurized fluid through the high velocity flow course while the pulse generating tool is disposed at the bottom of the borehole, thereby generating both compression waves and shear waves.

74. The method of Claim 73, wherein the step of collecting data corresponding to the compression and shear waves to generate the ratio of shear wave velocity to compression wave velocity profiles comprises the steps of:

(a) collecting data corresponding to the compression waves and shear waves produced while the pulse generating tool is disposed at the bottom of the borehole;

(b) circulating a pressurized fluid through the high velocity flow course while the pulse generating tool is disposed adjacent to the bottom of the borehole and not producing shear waves;

(c) collecting data corresponding to the compression waves while the pulse generating tool is disposed adjacent to the bottom of the borehole and not producing shear waves; and

(d) comparing the data collected while the pulse generating tool is adjacent the bottom of the borehole and not producing shear waves, with the data corresponding to the compression waves and shear waves produced while the pulse generating tool is disposed at the bottom of the borehole, to generate the ratio of shear wave to compression wave velocity.